# Oaks, Fire, Beetles, and Drought: The Persistence of Vigilance at the Front Edge of Invading Species

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# Public Health as a model for forest health and invasive species

- Reduce ignorance and denial
- Establish enlightened self interest
- Establish early warning systems
- Maintain vigilance
- Develop response to outbreaks
- Providing care and reconstruction
- Reducing the unknown to the unpredictable

Relatively small shift in perspective yields a great deal more efficiency in invasive species:

Arrival of GSOB

Susceptibility of hosts trees

Contagion across host trees

Amplification of GSOB

Dispersal of pests (host decline)

# ARRIVAL: Human Transport of FIREWOOD becomes the most likely model of GSOB dispersal into California

**Emerald Ash Borer, another Agrilus, are transport in wood products with**

**Evidence of Firewood Transport from AZ**

**Significant Barriers to Natural Dispersal**

**3 to 8 million year disjuncture between the woodland flora and fauna of southern California from Arizona**

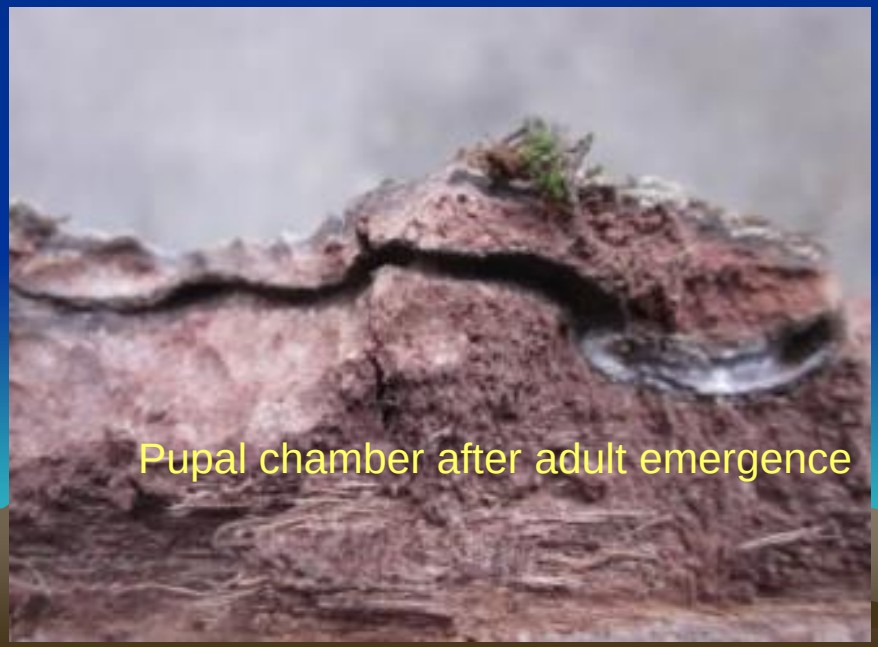
# ARRIVAL: Human Transport of FIREWOOD becomes the most likely model of GSOB dispersal into California

GSOB may need large arrival events like a wood distributor

We have had probability in our favor in private movement of firewood

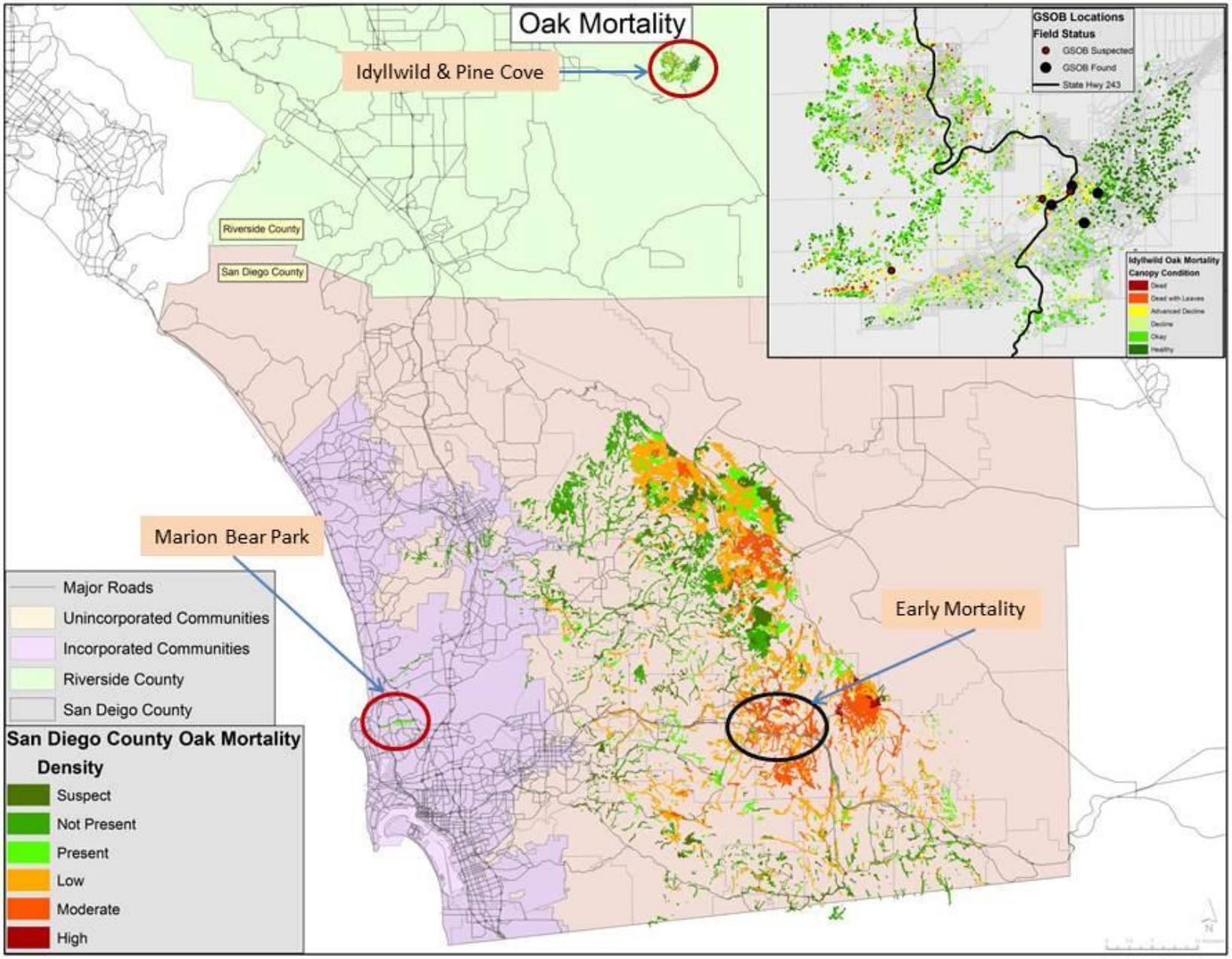
## GSOB life history is ideal for movement in firewood

GSOB Adults ready to emerge from oak firewood

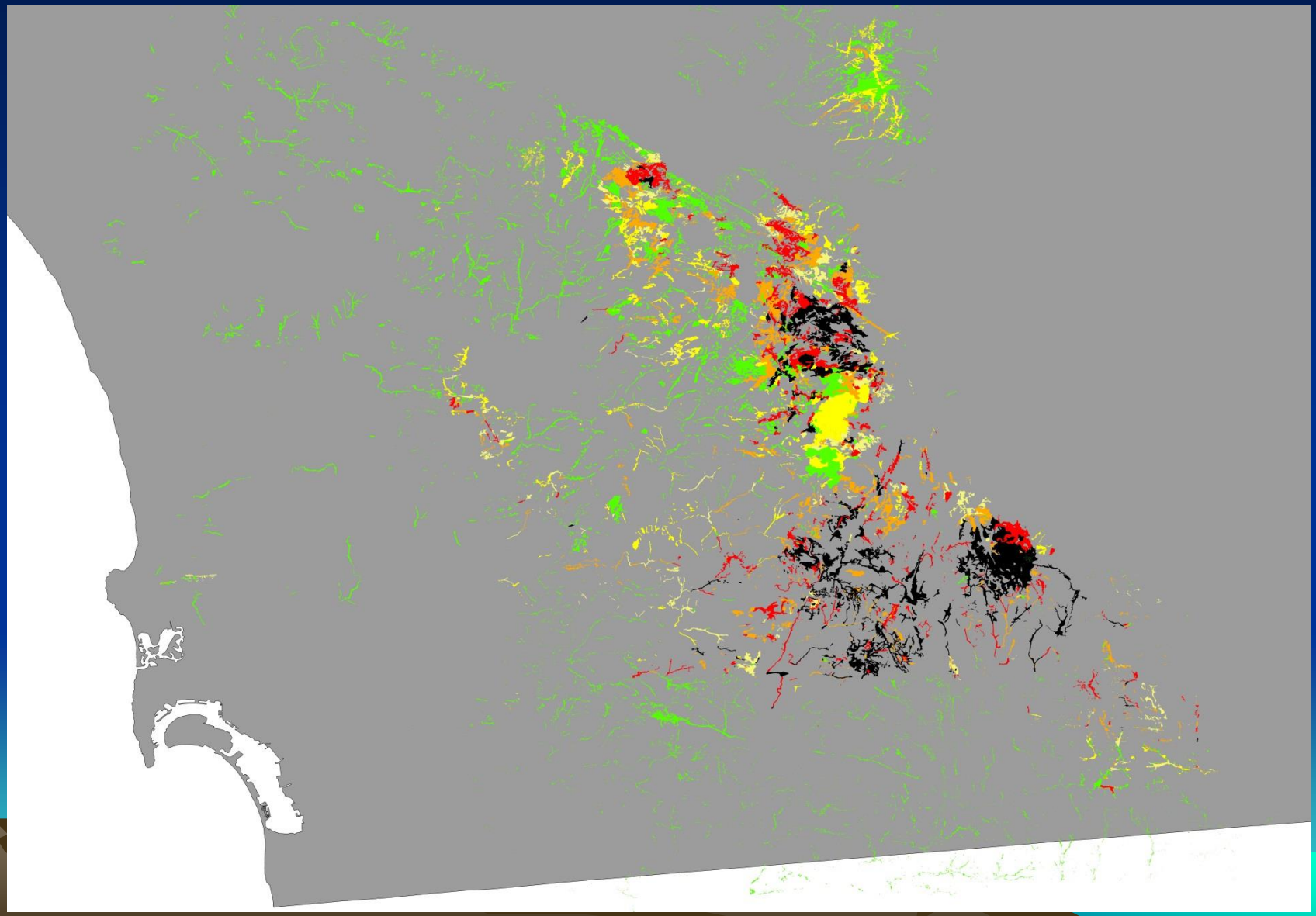


Pupal chamber after adult emergence

# Fall of 2013: GSOB isn't adept at dispersal



## Uneven levels of GSOB infestation



# Susceptibility:

More than just waiting for the next catastrophe. General notions of relatedness among oak species, subspecies and varieties

| *TAXA* | COMMON NAME | NARROW DISTRIBTUION |
|---|---|---|
| *Quercus kelloggii* Newb. | BLACK OAK | NO |
| *Quercus agrifolia agrifolia* Nee | COAST LIVE OAK | YES |
| *Quercus agrifolia oxyadenia* | (COAST LIVE OAK) | YES |
| *Quercus wislizeni* A. DC. var. *wislizeni* | INTERIOR LIVE OAK | NO |
| *Quercus wislizeni* var. *frutescens* Engelm. | (INTERIOR LIVE OAK) | NO |
| *Quercus peninsularis* | PENINSULAR OAK | YES |
| *Quercus parvula* Greene var. *parvula* | SANTA CRUZ ISLAND OAK | YES |
| *Quercus parvula* var. *shrevei* (Muller) Nixon & Muller | SHREVE OAK | YES |
| *Quercus chrysolepis* Liebm. | CANYON LIVE OAK | NO |
| *Quercus vaccinifolia* Kellogg | HUCKLEBERRY OAK | YES |
| *Quercus tomentella* Engelm. | ISLAND OAK | YES |
| *Quercus palmeri* (*Quercus dunnii*). | PALMERS OAK | NO |
| *Quercus cedrosensis* | CEDROS ISLAND OAK | YES |
| *Quercus sadleriana* R. Brown, Campst. | SADLER OAK | YES |
| *Quercus engelmannii* Greene | ENGELMANN OAK | YES |
| *Quercus lobata* Nee | VALLEY OAK | NO |
| *Quercus douglasii* H. & A. | BLUE OAK | YES |
| *Quercus garryana* Dougl. var. *garryana* | OREGON WHITE OAK | NO |
| *Quercus garryana* var. *breweri* Jeps. | | YES |
| *Quercus garryana* var. *semota* | | YES |
| *Quercus dumosa* Nutt. *sensus stricto* | COASTAL SCRUB OAK | YES |
| *Quercus berberidifolia* Liebm | SCRUB OAK | NO |
| *Quercus john-tuckeri* Nixon & Muller | TUCKER'S SCRUB OAK | YES |
| *Quercus pacifica* Nixon & Muller | PACIFIC OAK | YES |
| *Quercus cornelius-mulleri* Nixon & Steele | MULLER OAK | NO |
| *Quercus durata* Jeps. var. *Durata* | | YES |
| *Quercus durata* var. *gabrielensis* Nixon & Muller | | YES |
| *Quercus turbinella* Greene | ARIZONA SCRUB OAK | NO |

# Also have Growth Form Groups in California

| | | | |
|---|---|---|---|
| Single Stem Tree | Black Oak** | | Engelmann Oak |
| | Coast Live Oak** | | Valley Oak |
| | | | Blue Oak |
| Multiple Stem Tree | Interior Live Oak | Canyon Live Oak** | |
| | Shreve Oak | Island oak | |
| | Peninsular Oak (BC) | | |
| Intermediate | Pacific oak | Palmer's Oak (AZ) | Leather |
| | | Huckleberry Oak | Shrub Live Oak |
| Shrub | | Cedros Isl. Oak (BC) | Sadler oak |
| | | | California, Tucker, Muller, Nuttall Scrub Oaks |

# Looking for Patterns of Resistance:

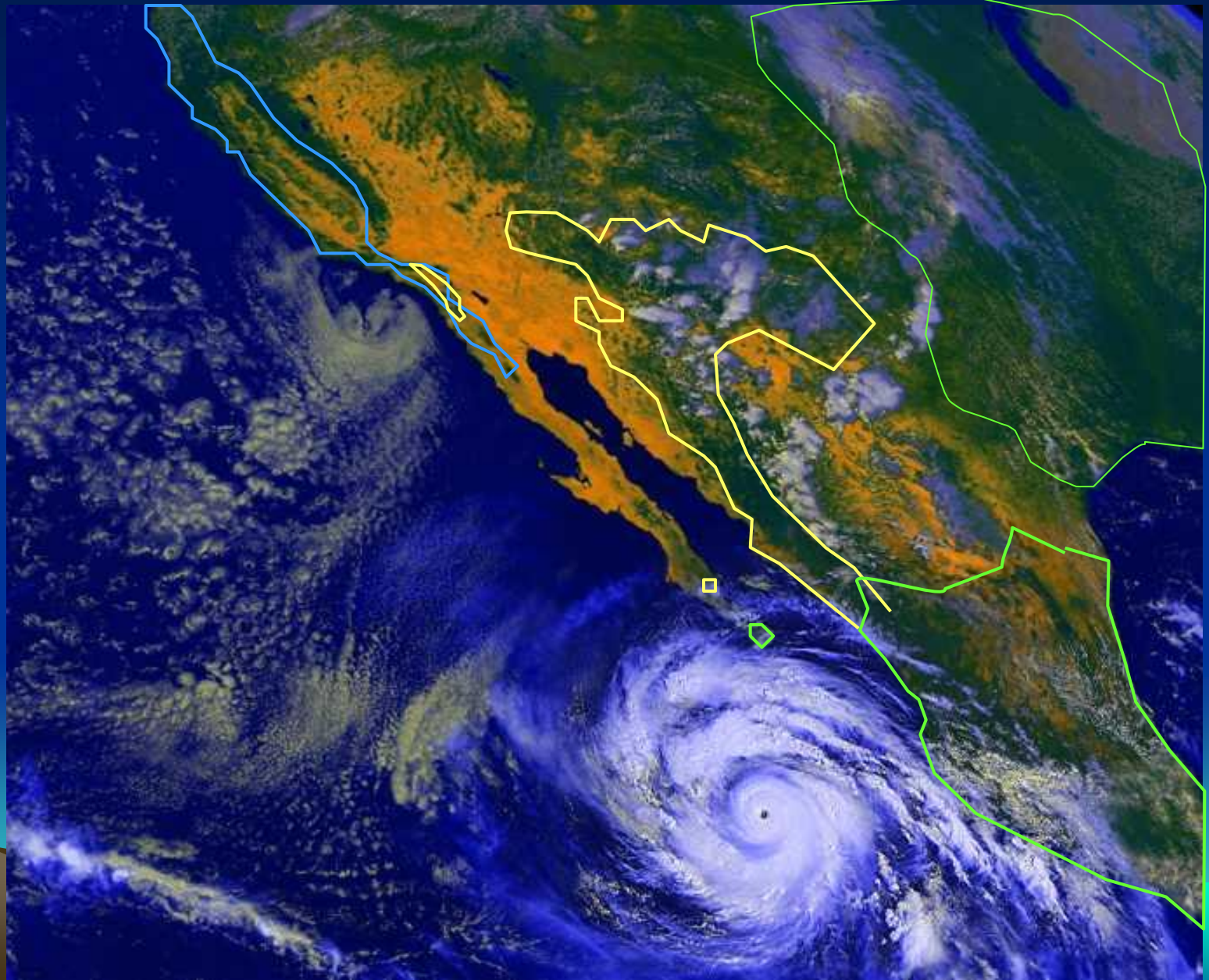
Hybrids unaffected after 12 years of outbreak

**Coast Live Oak**
***Quercus agrifolia***

**Hybrid Coast Live Oak and Interior Live Oak**
***Quercus agrifolia x wislizeni***

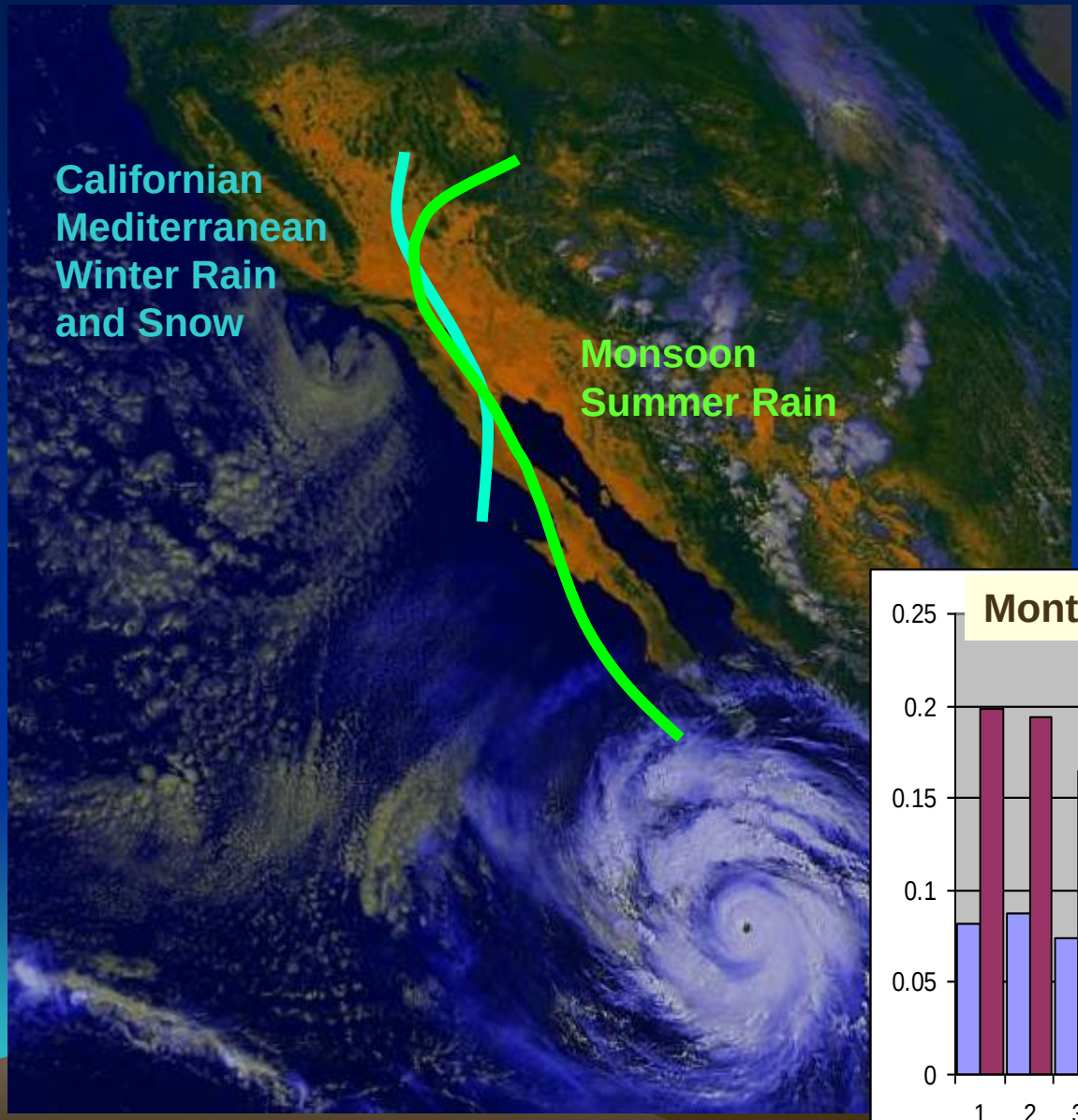
# Reasons for susceptibility:

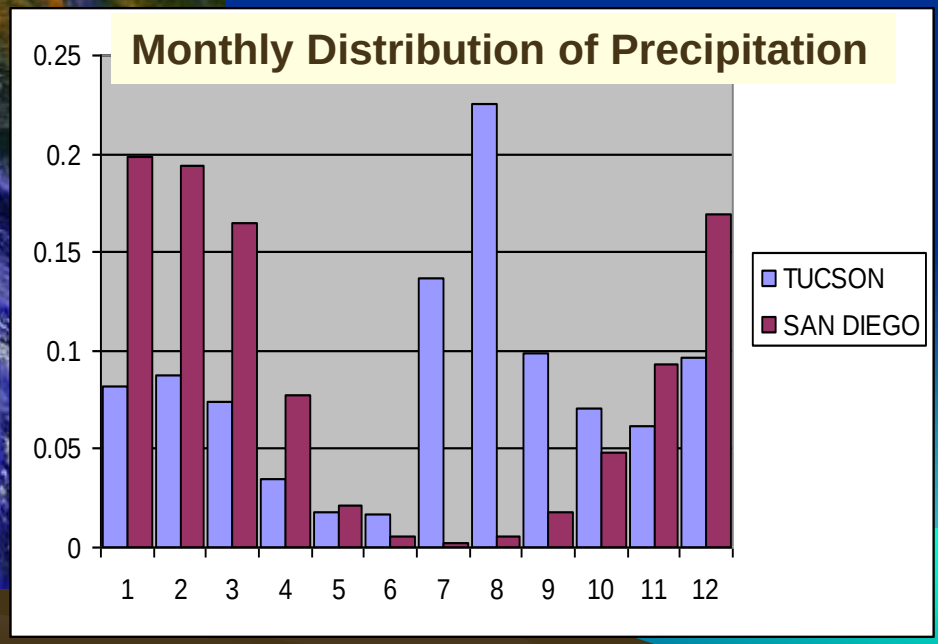
biogeographic isolation of California oaks increases their sensitivity to GSOB damage



# The contribution of stress to susceptibility:

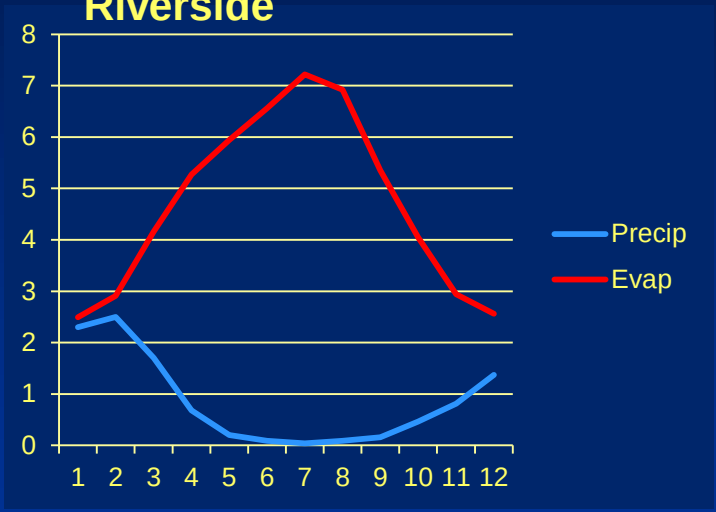
Mediterranean summer drought vs Monsoonal summer rainfall

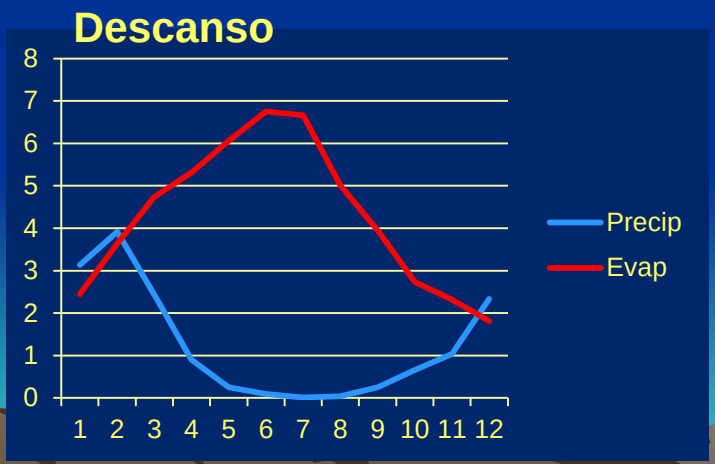


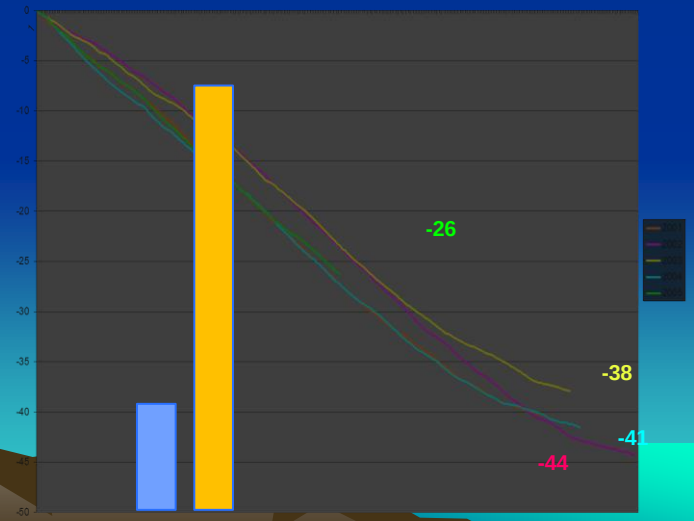



# Timing of Stress:

Precipitation, evapotranspiration, and summer drought stress in oak ecosystems

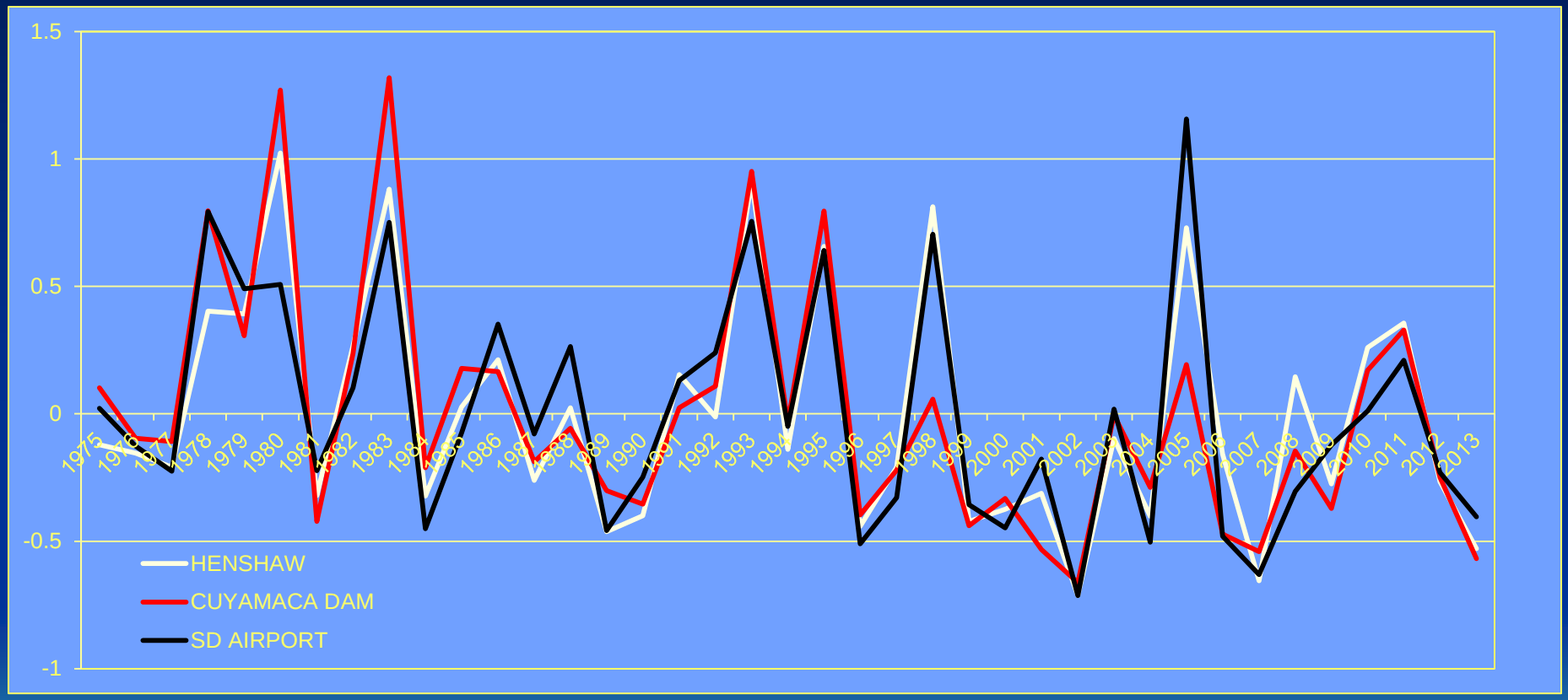



# Annual variation as an source of stress:

El niño, La niña, and nada: no average year of precipitation




Recent water-year (July to June) precipitation at three southern California locations

# Mining water from weathered bedrock creates a point stress



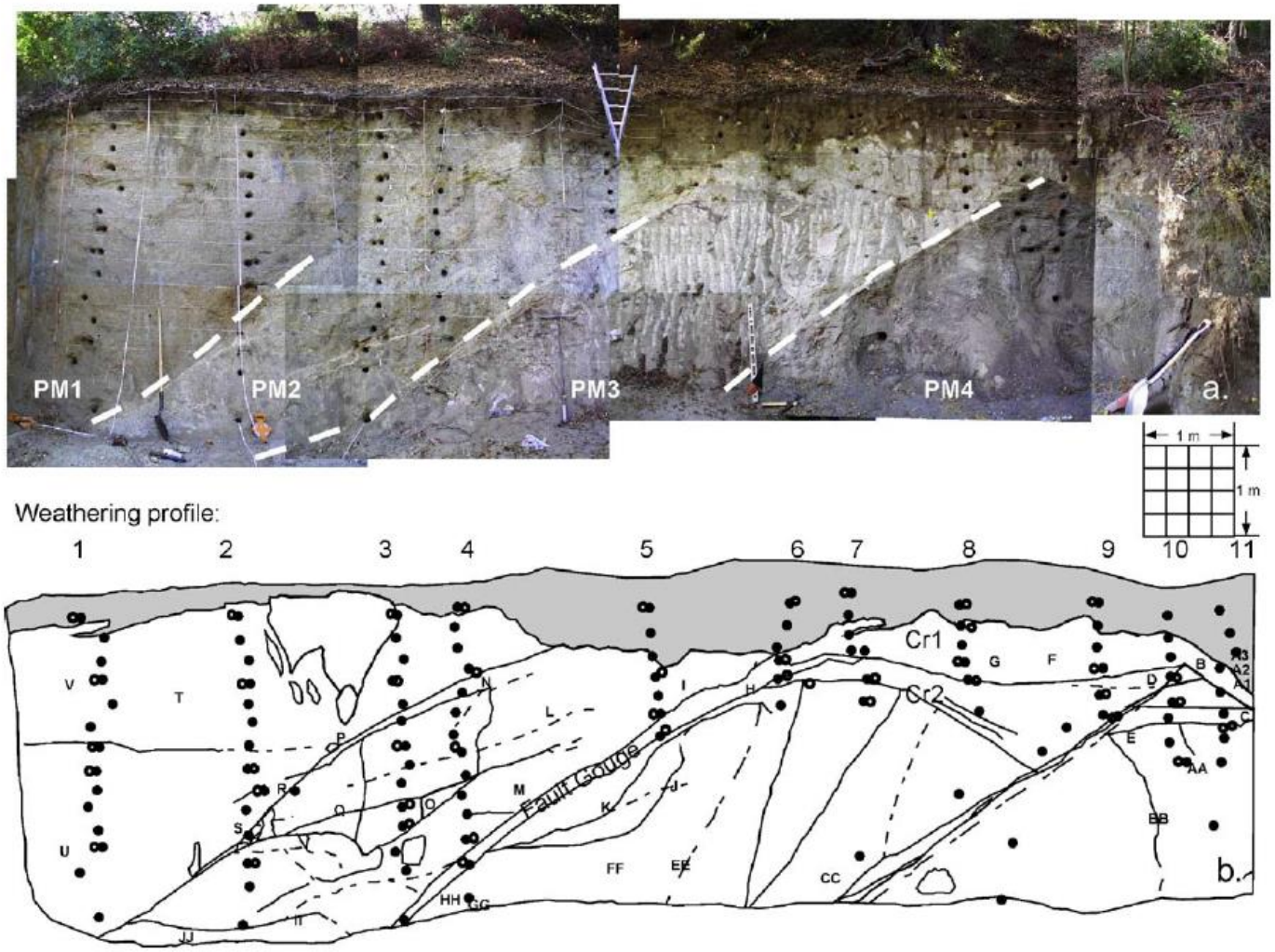
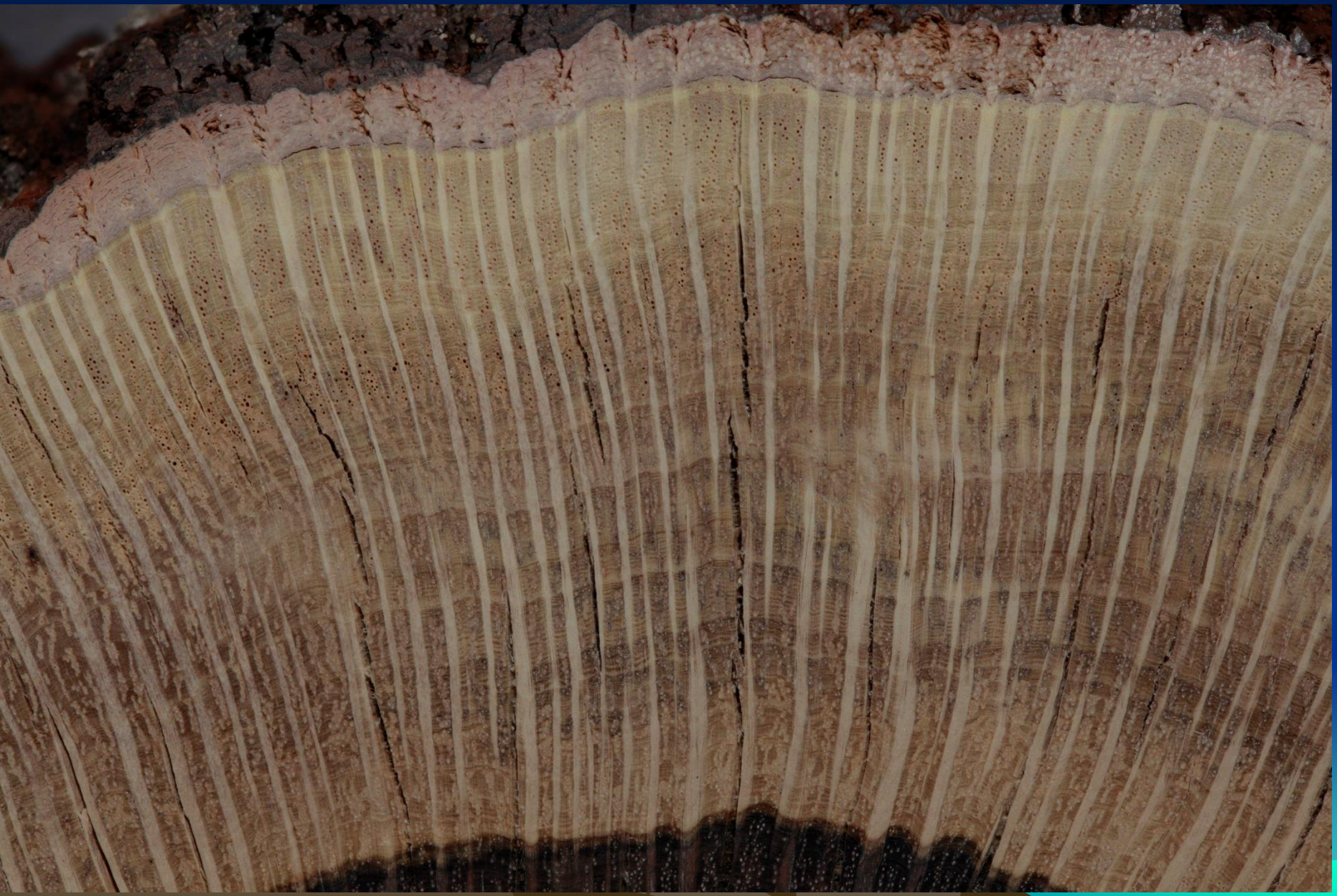



Fig. 2. (a) Photomosaic of the study profile and (b) scaled diagram showing the soil (grey) and weathered bedrock (white) areas with major fracture-features (solid lines), selected faint fracture-features (dashed lines), sampled weathering profiles (1–11), and sample locations for soil moisture and CEC (solid circles), sample locations for intact cores (open circles), and roots (capital letters). Dashed white lines in photomosaic (a) delineate parent material boundaries.

# Annual Growth Rings: Ghosts of Good Years



**Oaks are dependent on an efficient system of vessels, which can be disrupted by GSOB larva**

**CALLUS WOOD**

**Coast live oak (*Quercus agrifolia*) and Black Oaks (*Q. kelloggii*) trunks typically develop callus wood in response to beetle damage in bark, but response varies within and among sample locations**

| CALLUS PRODUCTION (DESCANSO) | 0-15° | 15-90° | 90-180° | 180-270° | 270-360° | total | percent |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| none | | | | | | 10 | 8% |
| single year | 1 | 7 | 13 | 7 | 24 | 52 | 43% |
| multiple years | | 7 | 5 | 6 | 40 | 58 | 48% |
| total | 1 | 14 | 18 | 13 | 64 | 120 | |
| percent | 1% | 12% | 15% | 11% | 53% | | |

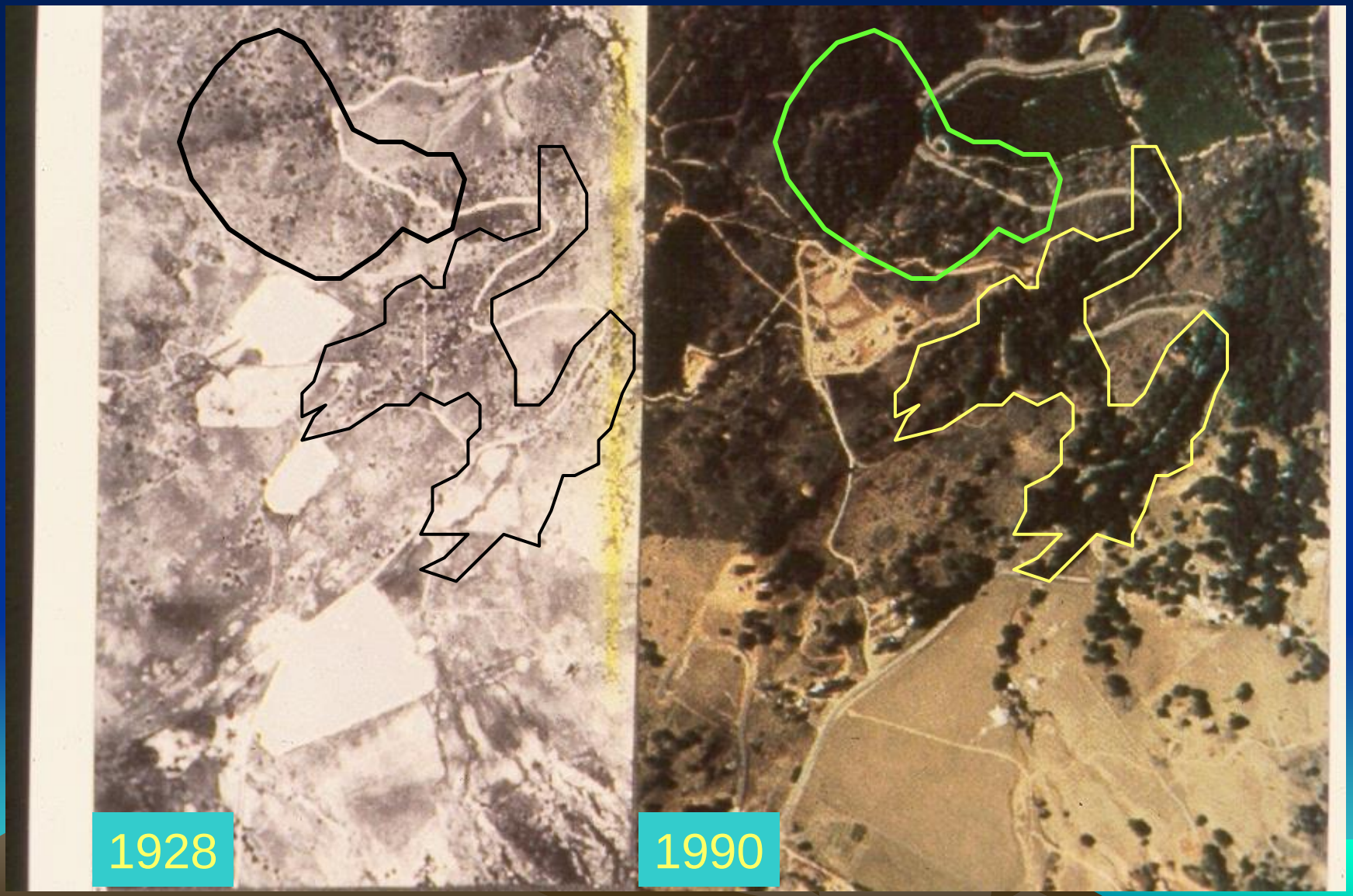
# PREDICTING YEARS TO DEATH: CUMULATIVE FREQUENCY OF OAK MORTALITY AFTER GSOB ATTACK

# Amplifying Host

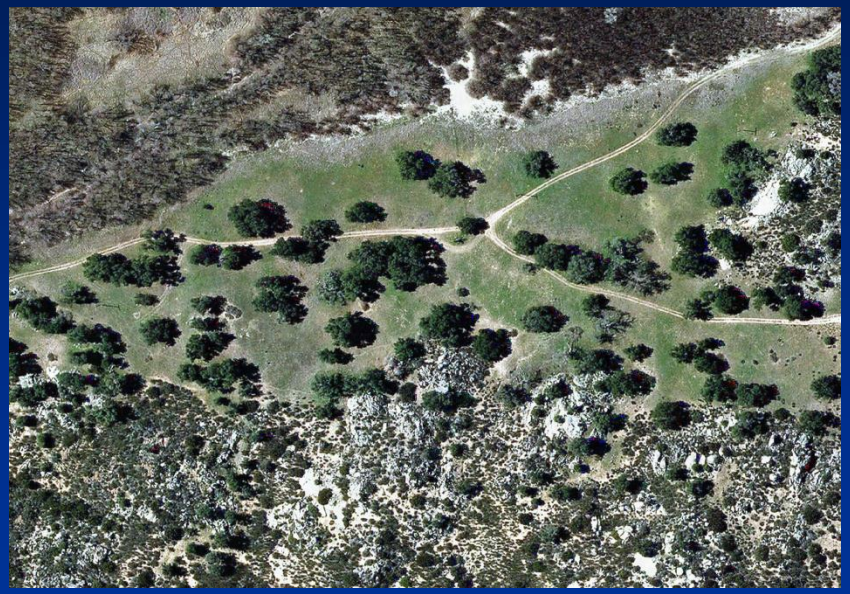
**AMPLIFICATION: Trees have recovered from past disturbance, but this creates synchrony among trees and puts large proportion of trees in older age classes**

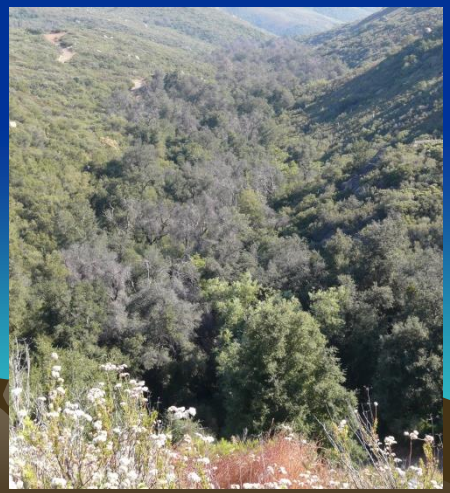

1928

1990

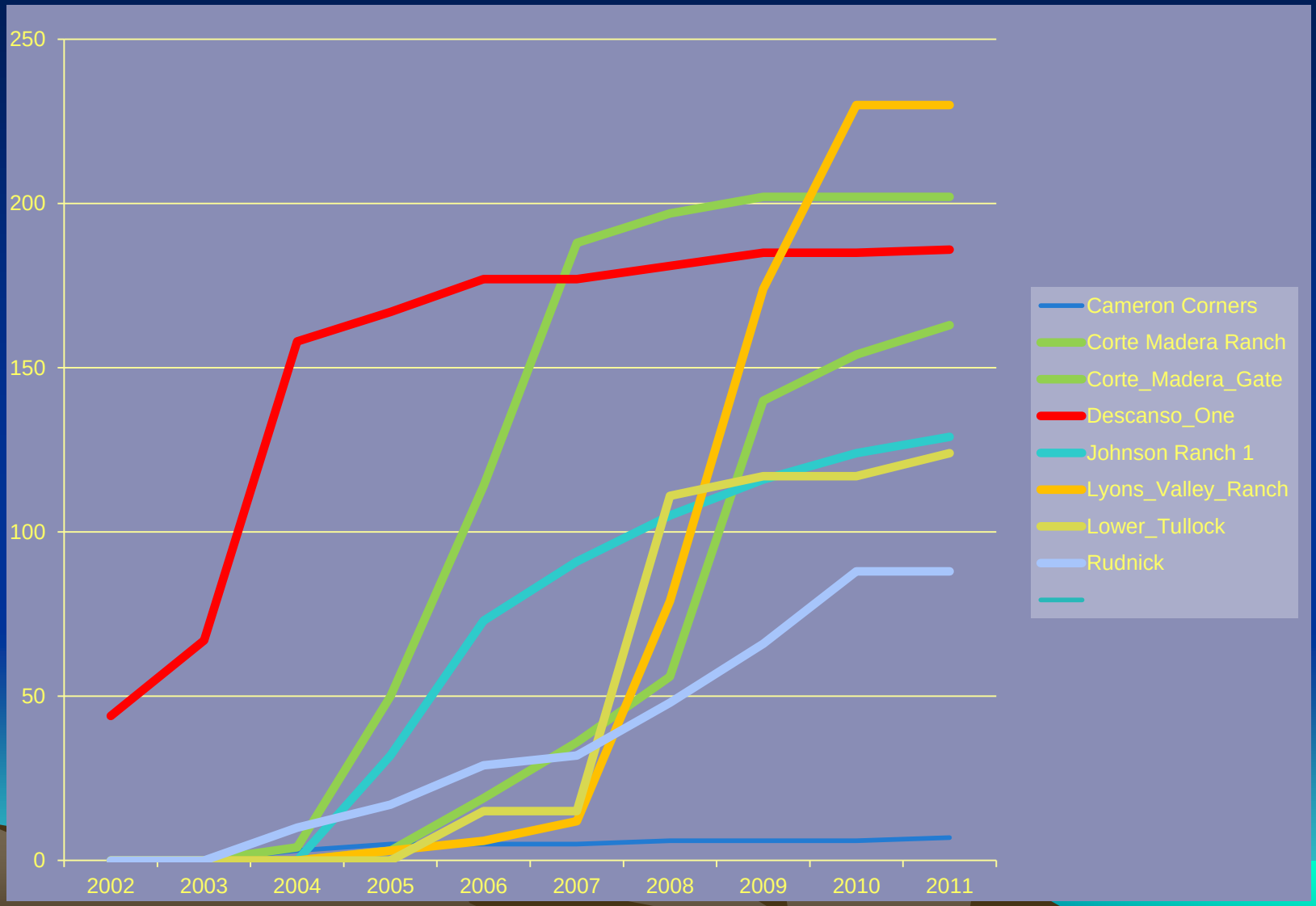

1928
1990

# Contagion: Dense stands of oaks are at higher risk for oak mortality than sparse woodlands





# CONTAGION AND AMPLIFICATION:
# Rates of GSOB-associated mortality in oak woodlands



# Translation to management

## Public Health as a model for forest health and invasive species

### Public at large

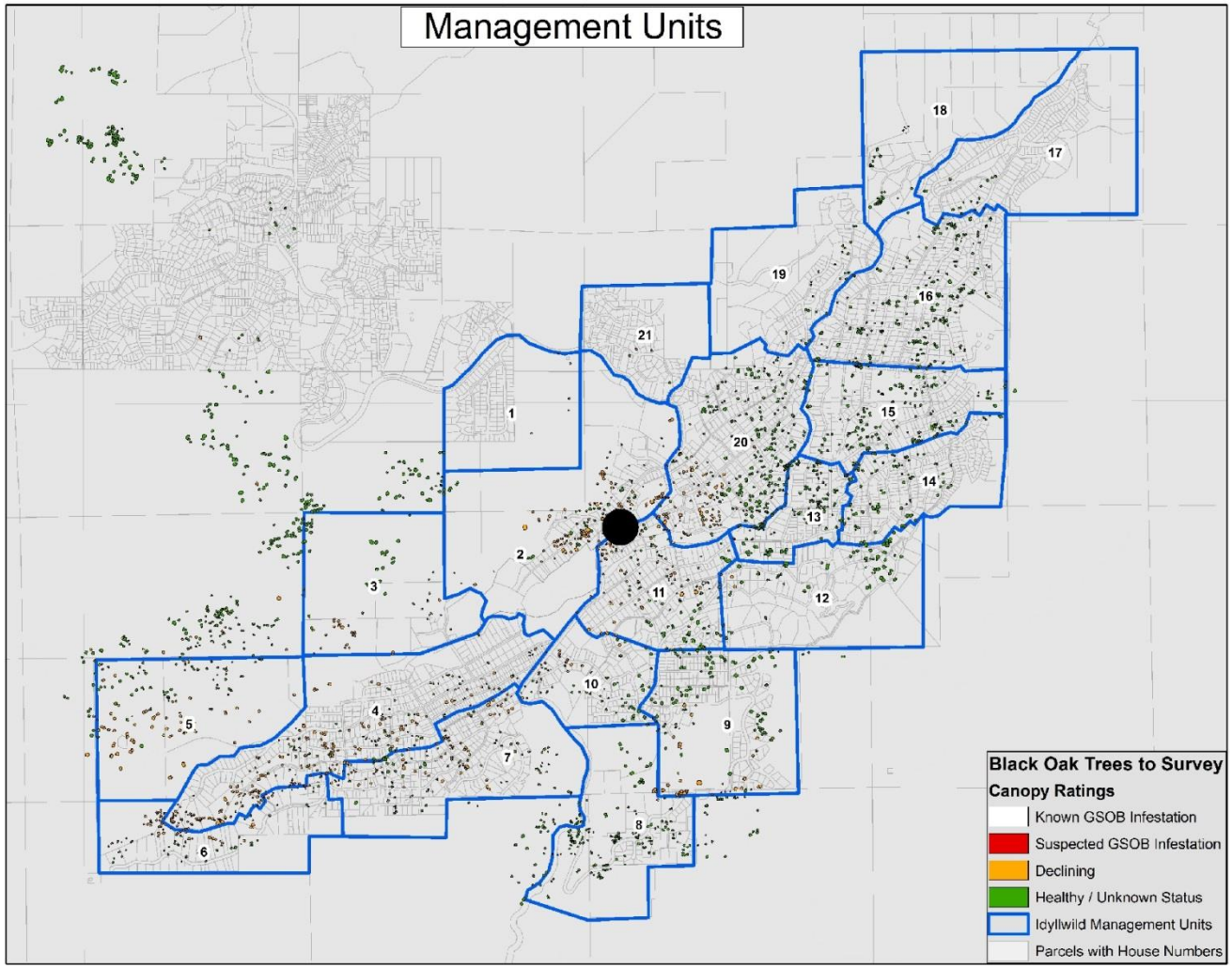
- Reduce ignorance and denial
- Establish enlightened self interest

### Paraprofessional, Volunteers, and Organizations

- Establish early warning systems
- Maintain vigilance

### Arborists and Foresters

- Develop response to outbreaks
- Providing care and reconstruction
- Reducing the unknown to the unpredictable


Management Units
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19
16
21
1
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20
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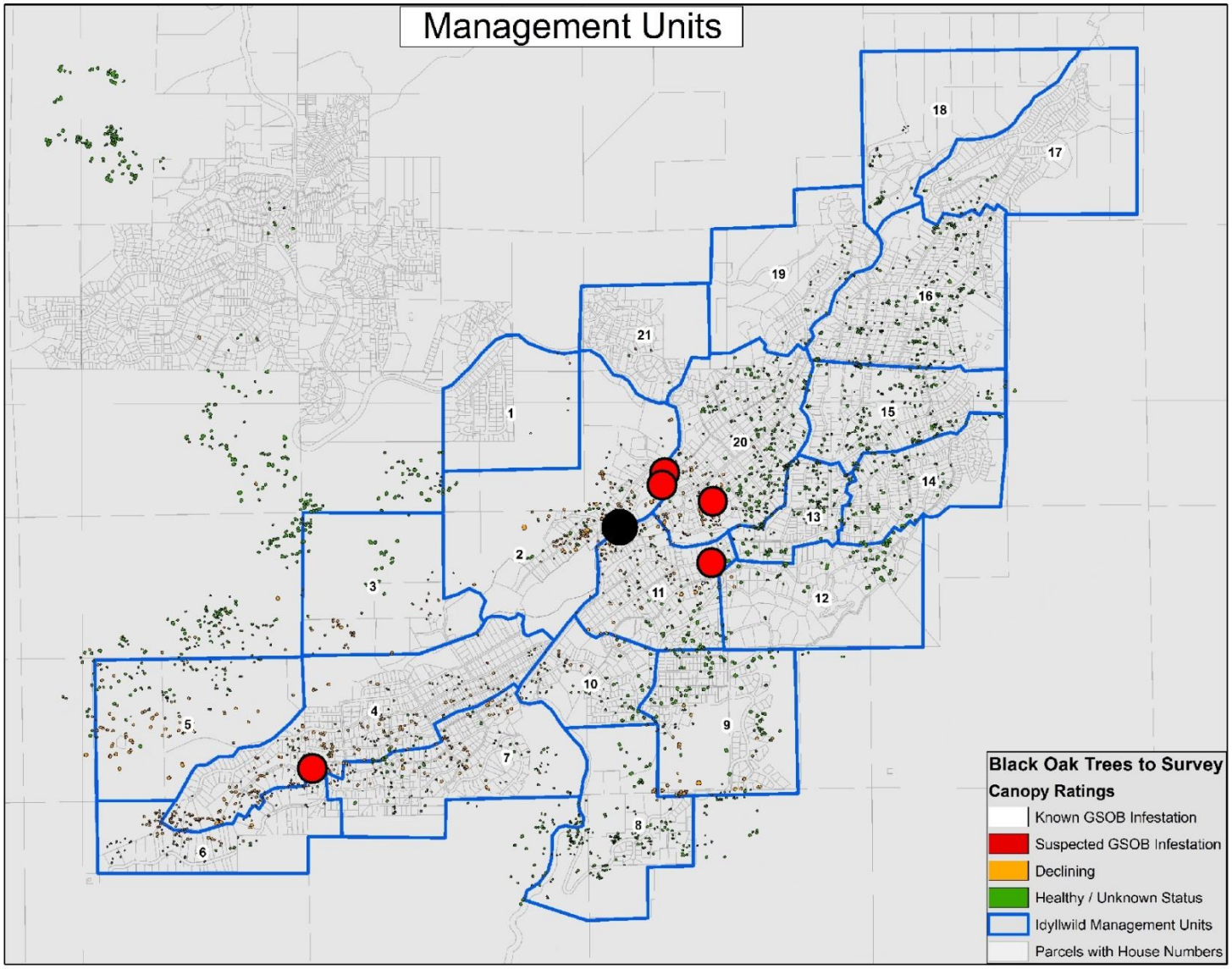
Black Oak Trees to Survey
Canopy Ratings
Known GSOB Infestation
Suspected GSOB Infestation
Declining
Healthy / Unknown Status
Idyllwild Management Units
Parcels with House Numbers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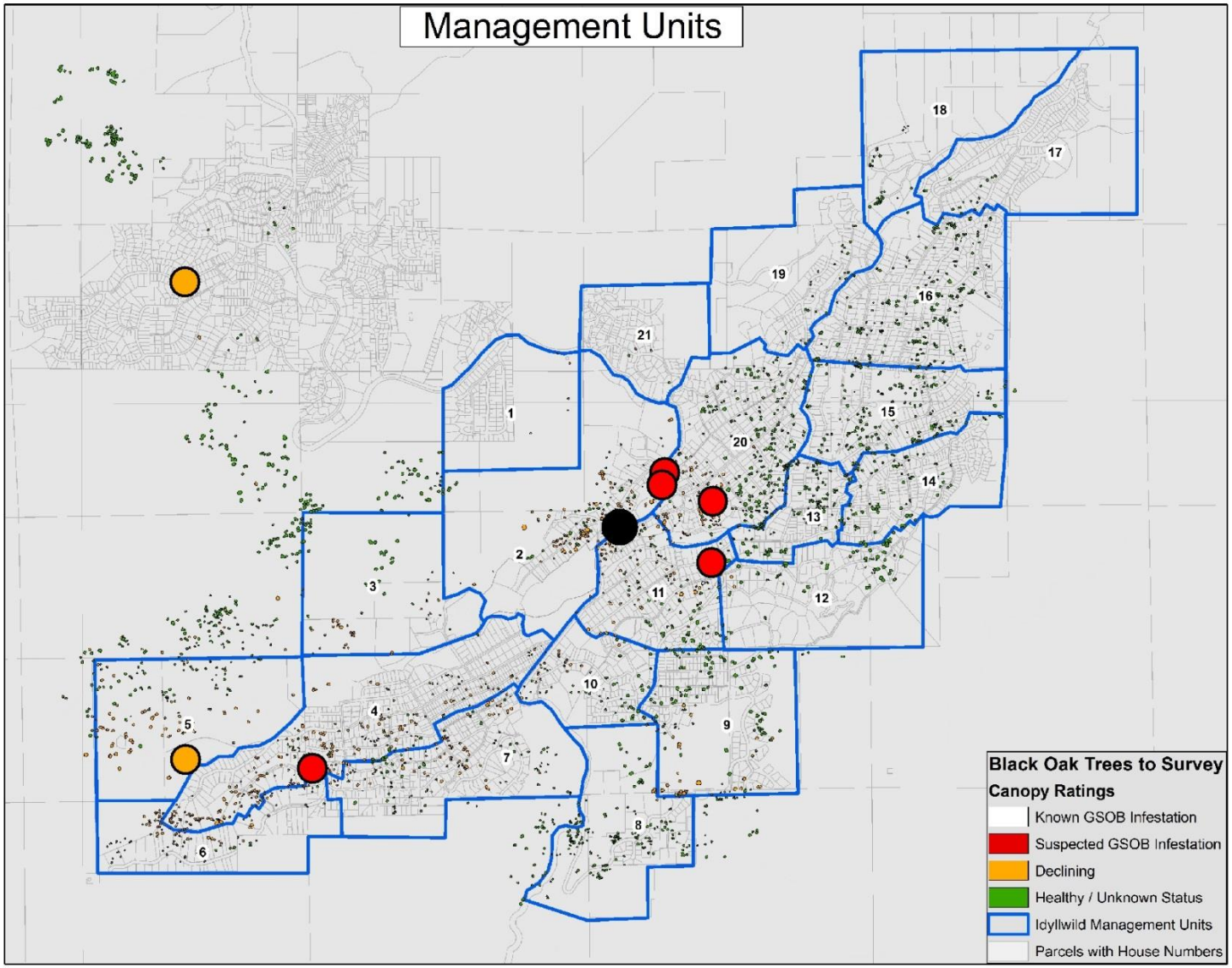
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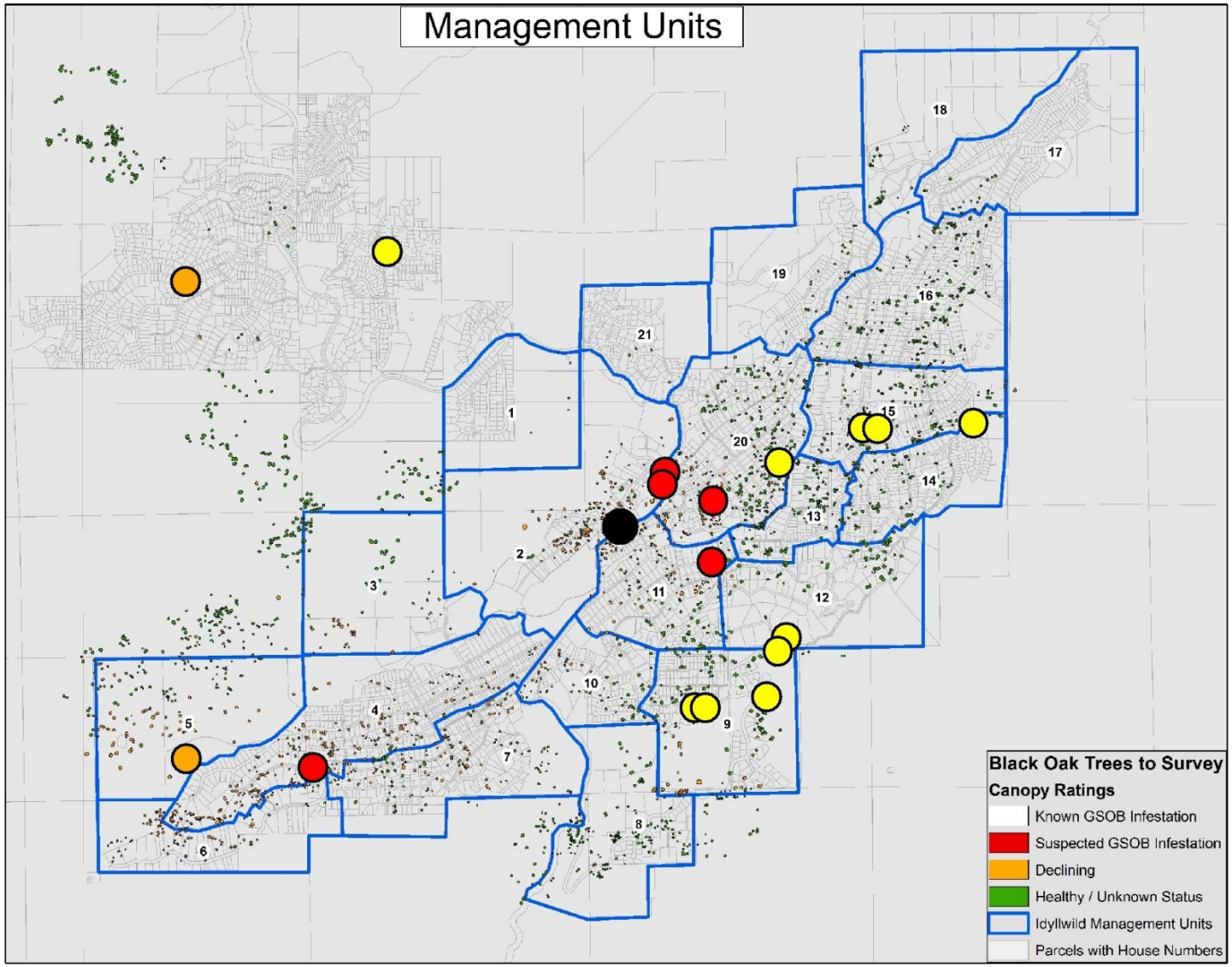
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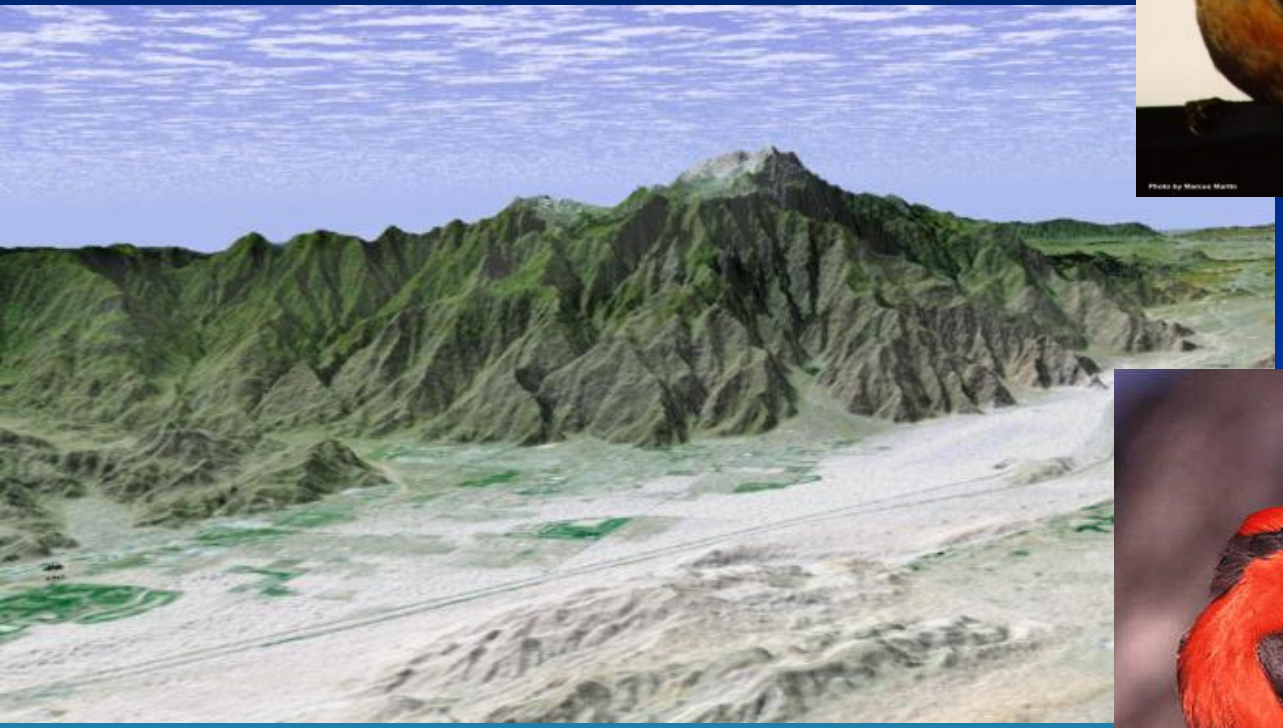
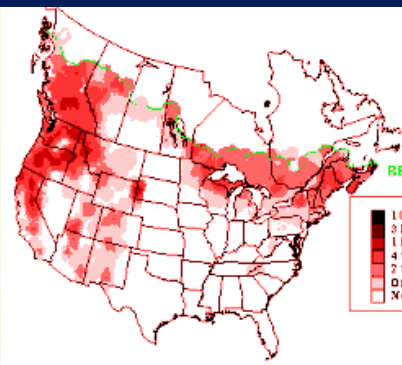
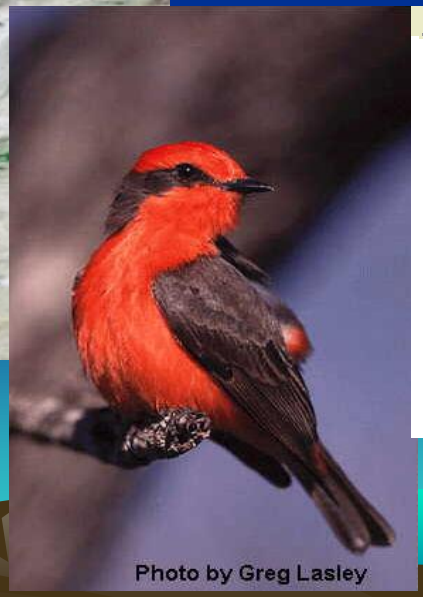
# Higher Provincialism
# Southern California is like no other place on earth

**Species disparity from the top of the mountain to the bottom (10 km) is equivalent to 2400 km of transition across the Midwest**





**Red-breasted Nuthatch (North to Yukon )**




**Vermillion Flycatcher (South to Equator)**

**More Information on Goldspotted Oak Borer**

http://ucanr.org/sites/gsobinfo/

http://www.fs.fed.us/r5/spf/fhp/gsob.shtml

http://ceres.ca.gov/foreststeward/html/treenotes.html

http://cisr.ucr.edu/goldspotted_oak_borer.html

**Cleveland National Forest** http://www.fs.fed.us/r5/cleveland/projects/projects/oak-borer/index.shtml

**Other partners:**

# For More Information

- **Goldspotted Oak Borer Websites**
  - http://www.gsob.org
  - http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn74163.html
  - http://ceres.ca.gov/foreststeward/pdf/treenote31.pdf
  - http://www.fs.fed.us/r5/cleveland/projects/projects/oak-borer/index.shtml
  - http://cisr.ucr.edu/goldspotted_oak_borer.html